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PUCHEROS Early Science: A New Be+sdO Candidate*

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Abstract. We report on the first scientific results with the recently commissioned PUCHEROS spectrograph, mounted at the 50 cm telescope of the Pontificia Universidad Catolica near Santiago, Chile. A hitherto unknown candidate Be+sdO binary was identified, *o* Pup. If confirmed, it would be the fourth member of this class. Such stars have obtained their rapid rotation through binary mass transfer and now consist of a Be star and a hot subdwarf.

1. Introduction

PUCHEROS is the newly built *Pontificia Universidad Catolica High Echelle Resolution Optical Spectrograph* (Vanzi et al. 2012). Most components are commercial off-the-shelf, enabling a cost-effective design (~25 000 USD for hardware). Light is fed into the instrument by an optical fiber, attached to the 50 cm telescope (the former ESO 50 cm at La Silla) at Santa Martina observatory near Santiago de Chile. See Table 1 for an overview of the instrument.

One of the science drivers for PUCHEROS are Be stars (see Porter & Rivinius 2003, for a review), with the two main purposes of monitoring objects for activity to follow up, as well as to complement data from larger telescopes by providing a spectroscopic history to put the data in the context of temporal behaviour.

*Partly based on observations collected at the European Organisation for Astronomical Research in the Southern Hemisphere, Chile under Prog-ID 076.C-0164.

Table 1. Instrumental key values of PUCHEROS

Spectral Resolution $\lambda/\Delta\lambda$	20 000
Spectral coverage (single shot)	390–730 nm
Orders	60–106
Aperture on sky (diameter)	3.5''
Limiting mag. (1 hr, $S/N = 30$)	$V = 9$ mag
Detector	FLI-PL1001E
total efficiency	5%

Table 2. Observations of *o* Pup

Date	MJD	H α EW [Å]	V/R He I 6678
2011-3-07	55 627.15	-10.6	1.04
2011-3-29	55 649.01	-11.0	0.95
2011-3-30	55 650.07	-11.3	0.98
2011-4-04	55 655.03	-11.1	1.02
2011-4-07	55 658.05	-9.52	1.05
2011-5-05	55 686.03	-10.2	0.95
2011-6-17	55 729.95	-11.7	1.00
2012-1-20	55 946.09	-11.8	1.02
2012-1-24	55 950.11	-10.5	0.95

2. Observations

Observations were carried out from Santa Martina in commissioning mode in the first half of 2011. In the second half of the year, during telescope maintenance and re-coating, the instrument was worked over according to the commissioning results, and is back in operation since December 2011. The commissioning targets already included several Be stars, which were identified in archival data as being interesting for long term monitoring.

PUCHEROS has started to monitor eleven bright Be stars by now. While most of the targets, Be and non-Be stars, are meant to built-up a long-term database, a few targets were chosen for immediate science return. For Be stars this was *o* Pup. The observation table for this target with PUCHEROS is given in Table 2.

3. Analysis

Based on the appearance of one archival FEROS spectrum, *o* Pup was suspected to be a Be+sdO type binary, of which only three confirmed (ϕ Per, 59 Cyg, and FY CMa: Gies et al. 1998; Rivinius et al. 2004; Maintz et al. 2005; Peters et al. 2008) and one candidate (Waters, Coté, & Pols 1991) are known. In such a system the hot secondary illuminates and excites a sector of the outer disk edge. This causes an additional emission bump to wander between red and blue with the orbital period, causing violet-to-red peak height variation (V/R) (Štefl, Hummel, & Rivinius 2000). To analyse this, the V/R

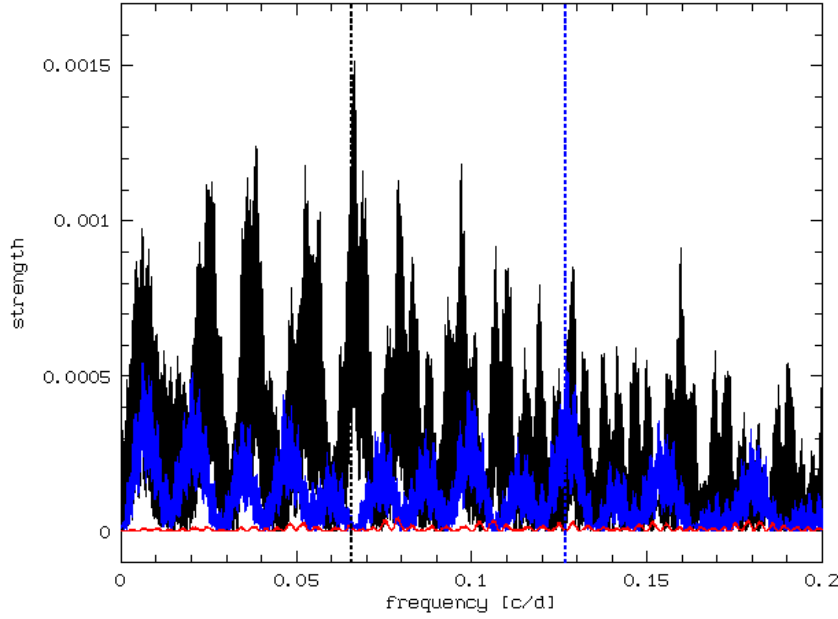


Figure 1. Periodogram of the V/R values. The original (black) and first (blue) and second (red) iteration of period cleaning are shown.

values, complemented by the FEROS archival data and amateur measurements available at BeSS (Neiner et al. 2011), were subjected to a period analysis (see Fig. 1).

The data shows two significant periods, $15.183 \pm .013$ and $7.882 \pm .002$ d, before the residuals are effectively flat. Due to inclusion of data from seasons before 2011/12, the formal errors are small, but aliasing vs. nearby ($\Delta f \approx n \times 1/365$ d) peaks cannot be entirely excluded. For this reason, it is actually possible that the shorter period is the first harmonic of the second.

Although Fig. 1 looks striking, it was not possible to fully exclude the main period to have another value. In fact, only slightly less significant values for the true period are 26 and 40 days. More data, currently being taken, might change the relative significance between these three.

4. Results

The measured V/R ratio in the He I 6678 line was subjected to a period analysis. The strongest peak is at a period of 15.183 d, with a strong first harmonic. The current data is somewhat ambiguous, as other periods are possible as well due to strong aliasing (26 and 40 d). However, the presence of a strong and fast periodic V/R -variation has been firmly established. The possible periods rule out any but a binary hypothesis. Figure 2 shows the variability of the He I 6678 and $H\alpha$ line profiles, folded with the 15.183 d period.

- In addition to the confirmed systems ϕ Per, 59 Cyg, and FY CMa, and the candidate HR 2142, σ Pup is the fifth potential Be+sdO binary.

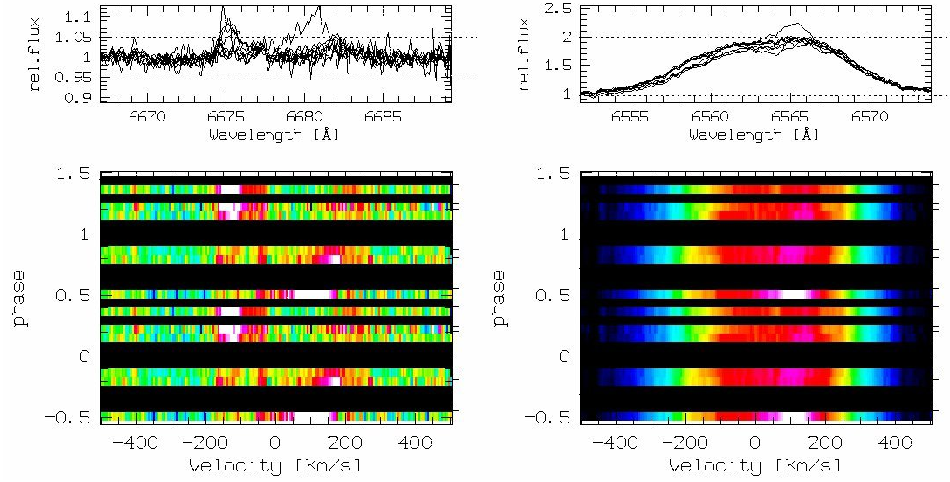


Figure 2. Phased spectra of He I 6678 (*left*) and H α (*right*) of *o* Pup

- The available data does not allow to distinguish between three possible periods of 15, 26, and 40 d. Additional observations are currently taken.

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Note added after submission

Only on September 23 did we learn about the paper by Koubský et al. (2012, A&A 545, A121), which, too, suggests *o* Pup to be the fourth Be+sdO candidate. Because the bulk of their observations, namely the high-cadence part, was obtained only after our poster was shown during the conference for which this contribution is submitted, held February 27 – March 2, 2012, we could not reference their work, which we would otherwise have done as a matter of course.

Thomas Rivinius (on behalf of the authors)